CHAPTER

3

LINEAR MEASUREMENT

Methods, Instruments used in chain surveying, Selection of stations, Chaining, Ranging, Offsetting, Errors in chaining and correction, Conventional symbols.

3.1 INTRODUCTION :

The determination of the distance between two points on the surface of the earth is one of the basic operations of surveying. Measurement of horizontal distances or measuring linear measurments is required in chain surveying, traverse surveying and other types of surveying. In surveying the distance between two points means a horizontal distance. As the map is plotted on a horizontal plane, the distances shown are the horizontal projections on this plane. When sloping distances are measured in surveying, these are always reduced to the equivalent horizontal distances for mapping purposes.

3.2 METHODS :

There are three methods of making linear measurements.

(1) Direct methods
(2) Optical methods
(3) E.D.M. methods

In the direct method, the distance is actually measured during field work using a chain or a tape. This is the most commonly used method for linear measurements.

In the optical methods, principles of optics are used. The distance is not actually measured in field but it is computed indirectly. The instrument used for making observations is called tacheometer.

Electromagnetic Distance Measuring (E.D.M.) instruments have been developed quite recently.

These are practically replacing the measurement of distances using chains or tapes. There is a large variety of such instruments and depending upon the precision required, a particular EDM instrument should be used.

Approximate Methods :

It would be better to have some idea of approximate methods of measuring the distances. The methods given below may be used in reconnaissance or for detecting major mistakes in linear measurements obtained with a chain or a tape.

Pacing :

A distance between two points can approximately be determined by counting the number of paces and multiplying it with average length of the pace.

Passometer :

It is a small instrument which counts the number of paces.

Pedometer :

This instrument directly gives the distance by multiplying the number of paces with the average pace length of the person carrying the instrument.

Odometer :

An odometer is a simple device which can be attached to the wheel of a bicycle or any such vehicle. The odometer registers the number of revolution made by the wheel. The distance covered is equal to the product of the number of revolutions and the perimeter of the wheel.

Speedometer :

This is used in automobiles for measuring distances.

Measuring Wheel :

It is a wheel fitted with a fork and handle. The wheel is graduated and shows a distance per revolution. There is a dial which records the number of revolutions. Thus the distance can be computed.

3.3 INSTRUMENTS USED IN CHAIN SURVEYING : (GTU June 2009)

The following instruments are used while chaining :

(1) Chains
(2) Tapes
(3) Arrows
(4) Ranging rods and offset rods
(5) Pegs
(6) Plumb-bob etc.

3.3.1 Chains :

Various types of chains used in surveying are :

(1) Metric chain
(2) Gunter's chain or Surveyor's chain

(3) Engineer's chain
(4) Revenue chain
(5) Steel band or band chain

(1) Metric Chain :

Normally, this chain consists of galvanised mild steel wire of 4 mm diameter known as link. (Fig. 3.1) The ends of the links are bent into a loop and connected together by means of three oval or circular rings which provide flexibility to the chain and make it less liable to kinking. Both ends of the chain have brass handles with swivel joint so that the chain can be turned round without twisting. The length of the chain is considered from outside surface of one handle to the outside surface of the other handle at the end. Similarly the length of link is the length between the centres of the two central rings provided at both ends of the chain. In metric chain length of one link is 20.00 cm as explained here.

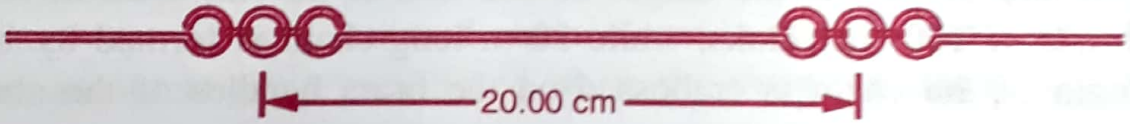


Fig. 3.1 Link

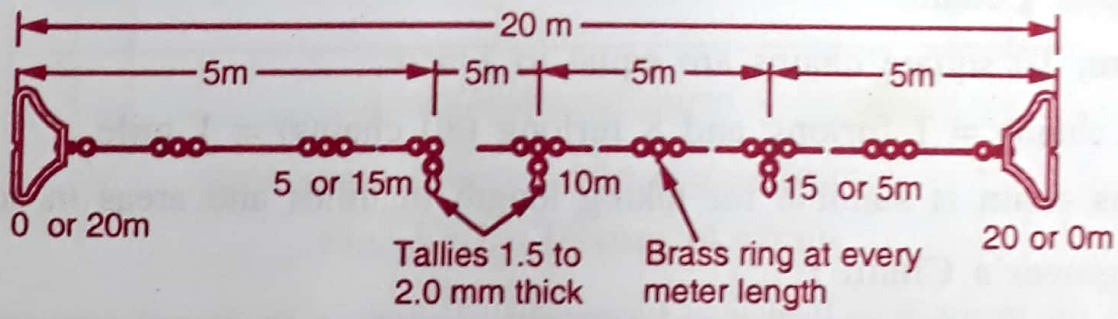


Fig. 3.2 20m chain

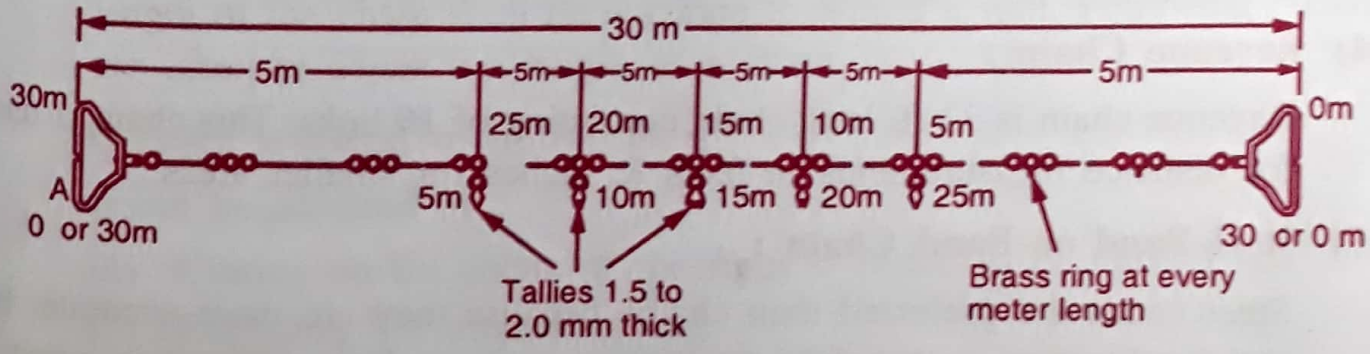


Fig. 3.3 30m chain

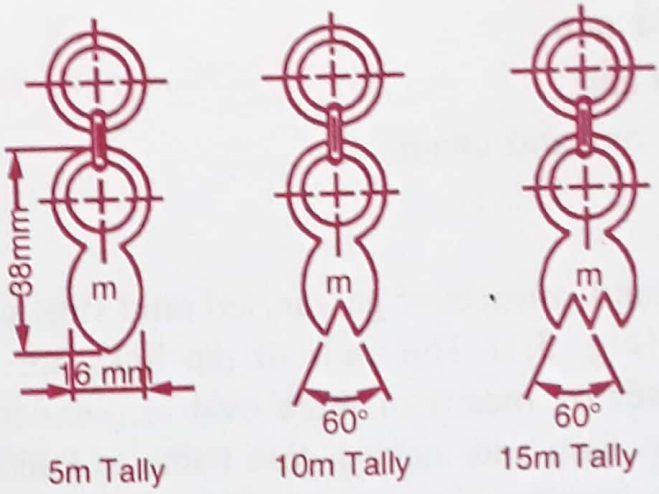


Fig. 3.4 Tallies or Tags

At every one meter length of chain, a small brass ring is provided. Brass tallies (Fig. 3.4) are also provided at every 5.0 m length of chain. Each tally has different shape which indicates either 5.0 m, 10.0 m or 15.0 m from any one of the ends of the chain. Metric chains are available in length of 20 m and 30 m. As the length of one link is 20 cm, a 20 m long chain consists of 100 such links, while 30 m long chain is formed by 150 links. Length of the chain is embossed on the brass handles of the chain.

(2) Gunter's chain or Surveyor's Chain :

A 66 feet long chain consist of 100 links, each of 0.66 ft. is known as Gunter's chain.

Here, 10 square chains are equal to 1 acre,

10 chains = 1 furlong and 8 furlong (80 chains) = 1 mile.

This chain is suitable for taking length in miles and areas in acre.

(3) Engineer's Chain :

A 100 ft. long chain consisting of 100 links each of 1 foot is known as Engineer's chain. Brass tags are fastened at every 10 links. This chain is used to measure length in feet and area in square yards.

(4) Revenue Chain :

Revenue chain is 33 ft. long chain consisting of 16 links. This chain is used for distance measurements in feets & inches for smaller areas.

(5) Steel Band or Band Chain :

Steel bands are preferred than chains because they are more accurate, but the disadvantage is that they get broken easily and are difficult to repair in the field. They are 20 and 30 m long, 12 to 16 mm wide and 0.3 to 0.6 mm thick. They are numbered at every metre and divided by brass studs at every 20 cm. (Fig. 3.5(a)).

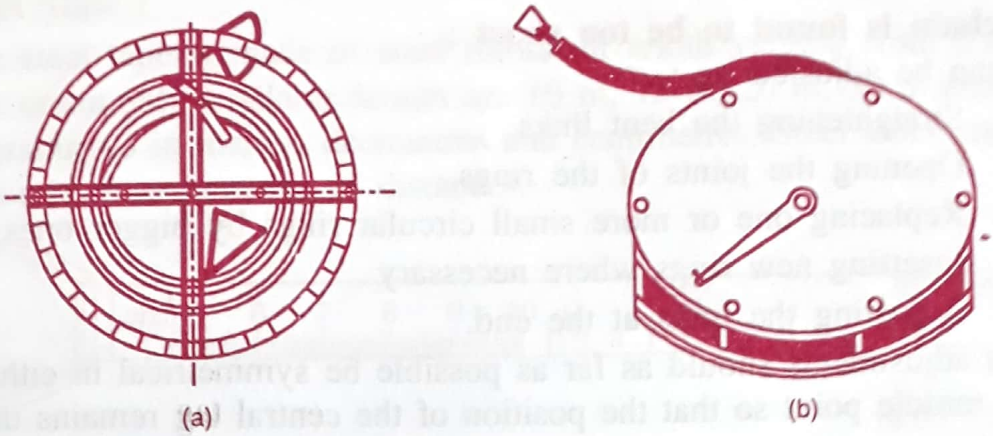


Fig. 3.5(a) Steel bands

Testing and Adjustment of Chain :

During continuous use, the length of a chain gets altered. Its length is shortened chiefly due to the bending of links. Its length is elongated either due to stretching of the links and joints and opening out of the small rings. For accurate work it is necessary to test the chain time to time. The chain can be thus tested by a steel tape or by a standard chain. Sometimes, it is convenient to have a permanent test gauge established where the chain is tested (Fig. 3.5(b)).

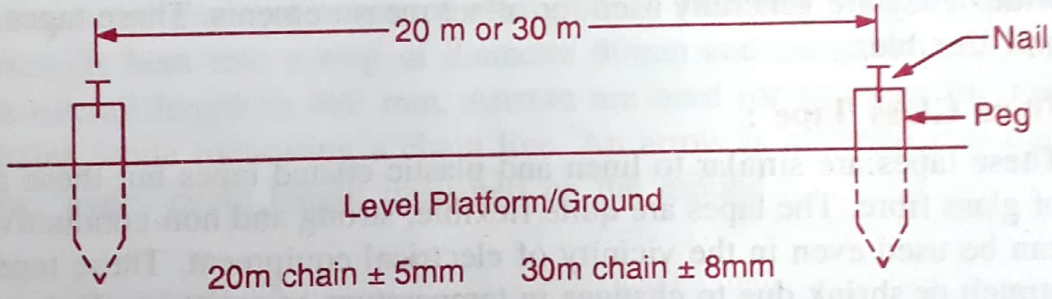


Fig. 3.5(b) Testing of chain

When the length of a chain is measured at a pull of 8 kg at 20 deg c., the length of the chain should measure 20 m ± 5 mm and 30 m ± 8 mm for 20 m and 30 m long chains respectively. In addition to this, every metre length of the chain shall be accurate to within 2 mm. Following measures are taken to adjust the length of a chain.

If chain is found to be too long :

It can be adjusted by :

(1) Closing up the joints of the rings if found to be opened out.
(2) Reshaping the elongated rings.
(3) Replacing damaged rings.
(4) Removing one or more small rings.
(5) Adjusting the links at the end.

If chain is found to be too short :

It can be adjusted by :

(1) Straightening the bent links.
(2) Opening the joints of the rings.
(3) Replacing one or more small circular rings by bigger ones.
(4) Inserting new rings where necessary.
(5) Adjusting the links at the end.

The adjustments should as far as possible be symmetrical in either side of the middle point so that the position of the central tag remains unchanged.

3.3.2 Tapes :

(GTU March 2009)

Tapes are used for more accurate measurements. The tapes are classified based on the materials of which they are made of such as :

(1) Cloth or linen tape (2) Fibre tape (3) Metallic tape
(4) Steel tape (5) Invar tape

(1) Cloth or Linen Tape :

Linen tapes are closely woven linen and varnished to resist moisture. They are generally 10 m, 20 m, 25 m and 30 m long in length and 12 to 15 mm wide. They are generally used for offset measurements. These tapes are light and flexible.

(2) Fibre Glass Tape :

These tapes are similar to linen and plastic coated tapes but these are made of glass fibre. The tapes are quite flexible, strong and non-conductive. These can be used even in the vicinity of electrical equipment. These tapes do not stretch or shrink due to changes in temperature or moisture. These tapes are available in lengths of 20 m, 30 m and 50 m lengths.

(3) Metallic Tape :

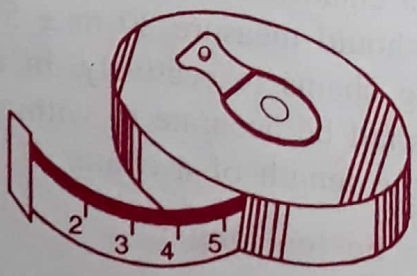


Fig. 3.6(a) Metalic Tape

A linen tape reinforced with brass or copper wires to prevent stretching or twisting of fibres is called a metallic tape. As the wires are interwoven and tape is varnished, these wires are visible to naked eyes. This is supplied in a leather case with a winding device. Each metre length is divided into ten parts (decimetres) and each part is further sub-divided into ten parts (centimetres). It is commonly used for taking offsets in chain surveying.

(4) Steel Tape :

The steel tape is made of steel ribbon of width varying from 6 to 16mm. The commonly available length are 10 m, 15 m, 20 m, 30 m and 50 m. It is graduated in metres, decimetres and centimetres. Steel tapes are used for accurate measurements of distances.

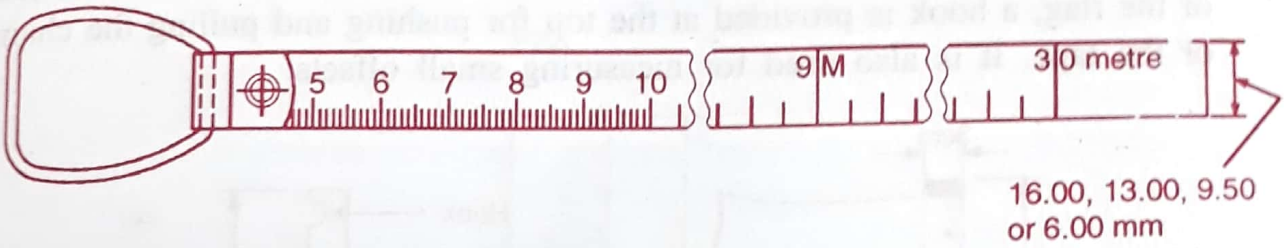


Fig. 3.6(b) Steel tape

(5) Invar Tape :

Invar tapes are made of an alloy of nickel 36% and steel 64% having very low co-efficient of thermal expansion. These are 6 mm wide and generally available in lengths of 30m, 50m, and 100m. It is not affected by change of temperature therefore, it is used when high degree of precision is required.

3.3.3 Arrows :

(GTU, April 2010)

Arrows are made of tempered steel wire of diameter 4mm. One end of the arrow is bent into a ring of diameter 50mm and the other end is pointed. Its overall length is 400 mm. Arrows are used for counting the number of chains while measuring a chain line. An arrow is insterted into the ground after every chain length measured on the ground.

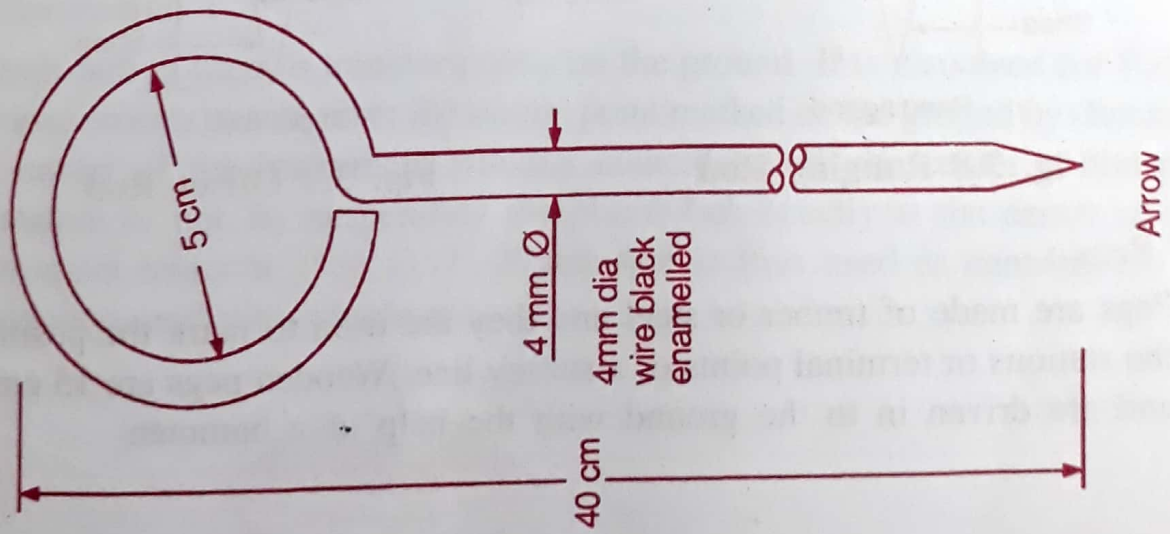


Fig. 3.7 Steel Arrow

3.3.4 Ranging Rods and Offset Rods :

Ranging rods are used for ranging some intermediate points on the survey line. Ranging rods are generally 2 to 3 m in length and are painted with

alternate bands of black and white or red and white colours with length of each equalising 20 cm. The location of any survey station can be known from long distances only by means of ranging rods. If the distance is too long, a rod of length 4.0 to 6.0 m is used and is called ranging pole.

The offset rod is similar to the ranging rod with the exception that instead of the flag, a hook is provided at the top for pushing and pulling the chain or the tape. It is also used for measuring small offsets.

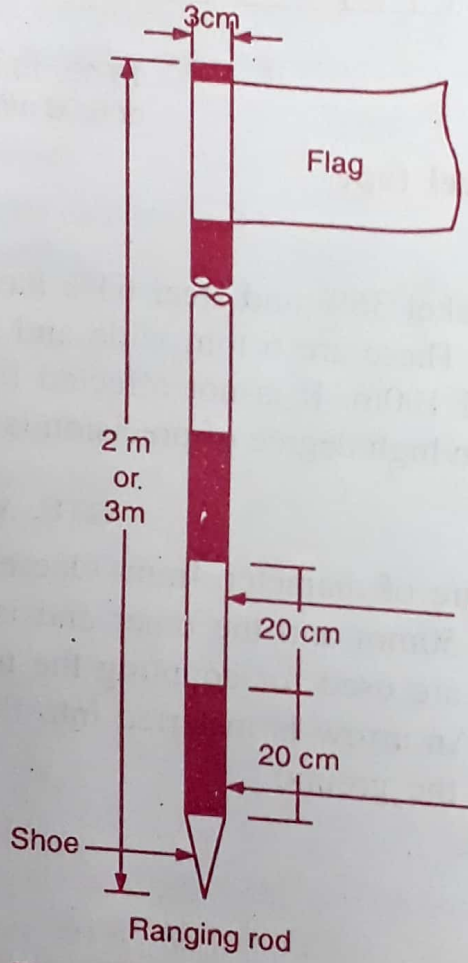


Fig. 3.8 Ranging Rod

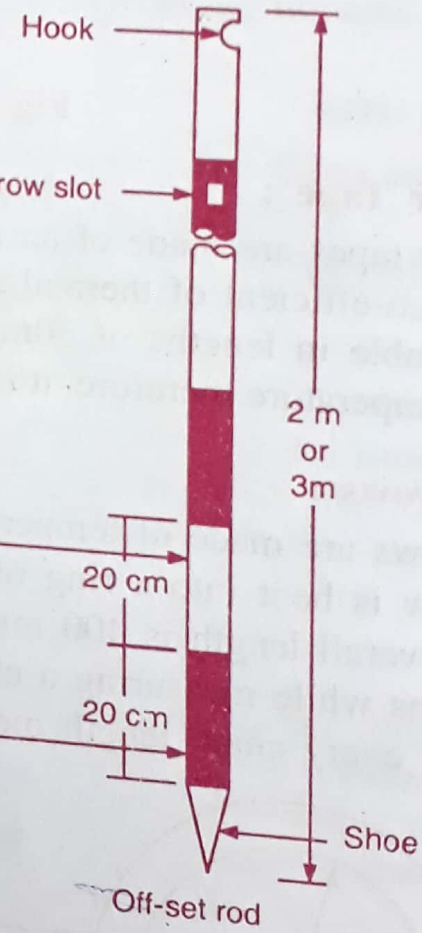


Fig. 3.9 Offset Rod

3.3.5 Pegs :

Pegs are made of timber or steel and they are used to mark the position of the stations or terminal points of a survey line. Wooden pegs are 15 cm long and are driven in to the ground with the help of a hammer.

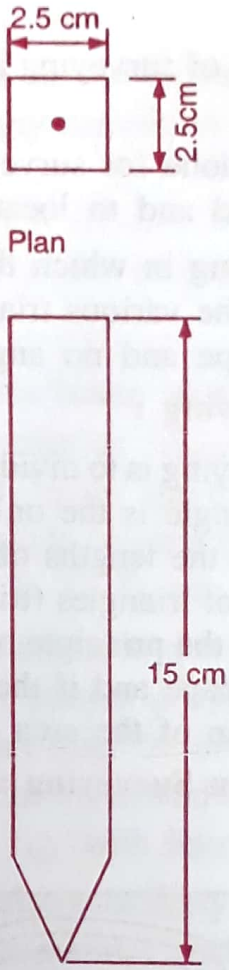


Fig. 3.10 Peg

3.3.6 Plumb-Bob :

Plumb-bob is used to transfer points on the ground. It is also used for fixing the instruments exactly over the station point marked on the ground by checking the center of the instrument whether coincides with the center of the peg or station or not, by suspending the plumb-bob exactly at the center of the instrument under it (Fig. 3.11). Plumb-bob is thus used as centring aid in theodolites and plane table etc.

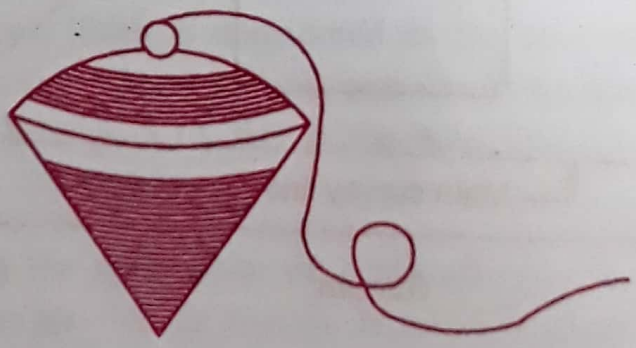


Fig. 3.11 Plumb-bob

3.4 CHAIN SURVEYING :

Chain surveying is the type of surveying in which only linear measurements are taken in the field.

This type of surveying is done for surveys of small extent to describe the boundaries of plots of land and to locate the existing features on them.

It is the method of surveying in which the area is divided into network of triangles and the sides of the various triangles are measured directly in the field with a chain or a tape and no angular measurements are taken.

3.4.1 Principle of chain surveying :

The principle of chain surveying is to divide the area into a number of triangles of suitable sides. As a triangle is the only simple plane geometrical figure which can be plotted from the lengths of the three sides even if the angles are not known. A network of triangles (triangulation) is preferred to in chain surveying. Triangulation is the principle of chain surveying. If the area to be surveyed is triangular in shape and if the lengths and sequence of its three sides are recorded, the plan of the area can be easily drawn.

3.6 OPERATIONS IN CHAIN SURVEYING :

The following operations are involved in chain surveying.

(1) Chaining (2) Ranging (3) Offsetting

These three operations are done simultaneously during chain surveying.

3.6.1 Chaining :

(1) Chaining on Level Ground :

The method of taking measurements with the help of a chain or a tape is termed as chaining.

Chaining involves following operations :

(1) Fixing the stations

(2) Unfolding the chain

(3) Ranging

(4) Measuring the distance (survey lines)

(5) Folding the chain.

Stations are first of all marked with pegs and ranging rods to make them visible.

There is a typical method of folding and unfolding the chain to prevent the problems of knots formed while unfolding the chain. After knowing that method, unfolding of chain is done between the station points and it is laid straight between the stations to measure correct length of the line.

If the length of the survey line is greater than one chain length, intermediate points are located, in order that the chain is pulled along a straight line. This is known as ranging a line (Fig. 3.13).

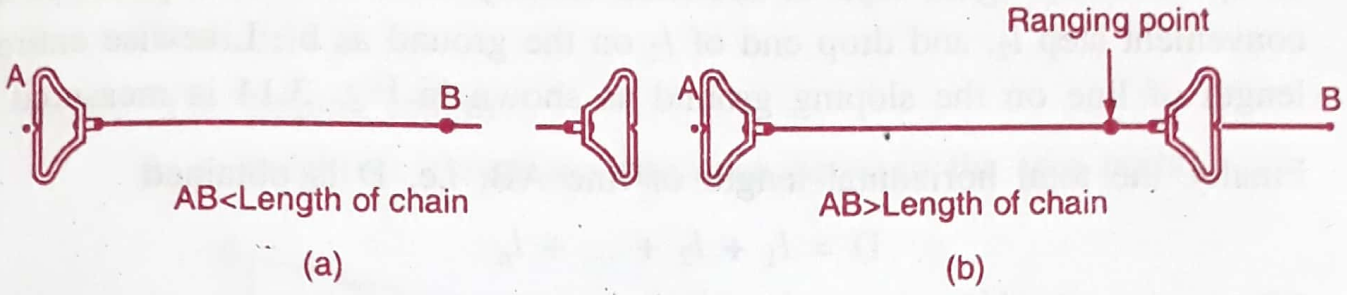


Fig. 3.13

After fixing the station points and intermediate points if required, a chain is stretched between the two points. The follower holds the zero end of the chain whereas the leader fixes up an arrow at the end of one chain length. The leader pulls the chain for measuring further distance. The leader goes on fixing arrows at the end of each & every chain length. At last, the follower collects all the arrows fixed by the leader while moving forward. At the end of the work, as a check the number of arrows are multiplied by the chain length which is the total length measured.

Finally at the end of work, the chain is folded and tied up with a coir thread.

(2) Chaining on Sloping Ground : (GTU, September 2009)

The object of a survey is to prepare a plan or a map. In the plan or a map the distance plotted between any two points is always a straight horizontal distance between them. Even if the chaining is done on a sloping ground, this sloping distance is converted into horizontal equivalent distance while plotting. There are two methods of finding out horizontal distance while chaining on a sloping ground.

(i) Direct method (ii) Indirect method.

(i) Direct Method :

This method is also called method of stepping. In this method, the distance is measured in small horizontal stretches. A suitable length of chain or tape say l_1 is taken. The follower holds the rear end of the tape at a point on the top of the hill or sloping ground. i.e. at point (A) (Fig. 3.14).

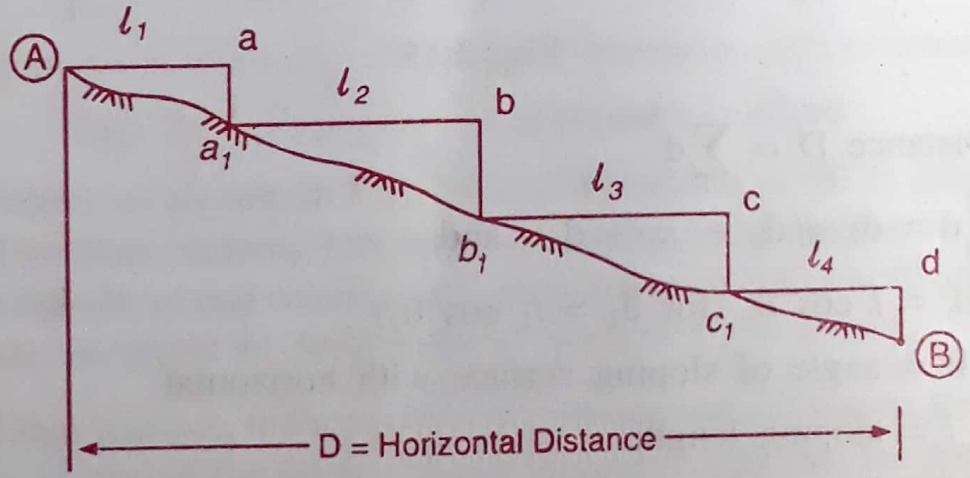


Fig. 3.14 Chaining on a Sloping Ground

3.6.3 Offsetting :

The method of taking perpendicular distances from the chain line to the objects which are to be plotted is known as offsetting. Thus, the distance measured from object to chain line is termed as an offset.

It is done to locate objects from chain line. Offsets are either taken on one side of the chain or both sides of the chain.

3.6.3.1 There are two types of offsets : (GTU, January 2010)

(i) Perpendicular offsets

(ii) Oblique offsets

(i) Perpendicular offsets :

The offsets which are taken perpendicular to the chain line are termed as perpendicular offsets. These offsets are taken by holding zero end of the tape at the object and swinging the tape on the chain line. The shortest distance whatsoever measured from object to the chain line is always a perpendicular offset.

(ii) Oblique offsets : Oblique distance is always greater than perpendicular distance. All the offsets which are not taken at right angle to chain line are known as oblique offsets.

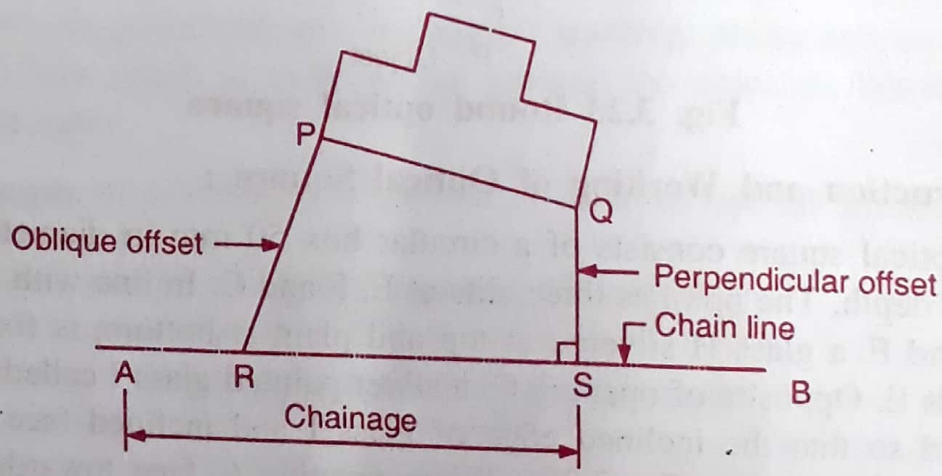


Fig. 3.22

The distance on the chain line at which the foot of the offset is taken is known as a **chainage**.

According to length, the offsets having length greater than or equal to 15.0 m are termed as **long offsets** and the offsets of length less than 15.0 m are known as **short offsets**. Short offsets are more accurate than long offsets.

3.6.3.2 Instruments for Laying Offsets :

Offsets are set by instruments such as

(1) Optical square
(2) Indian optical square
(3) Open cross staff
(4) Prism square

(1) Optical Square : (GTU Dec. 2008, April 20

This instrument is used for perpendicular offsets only.

Principle of Optical Square :

The angle between the incident ray and the reflected ray is twice the ang between the mirrors.

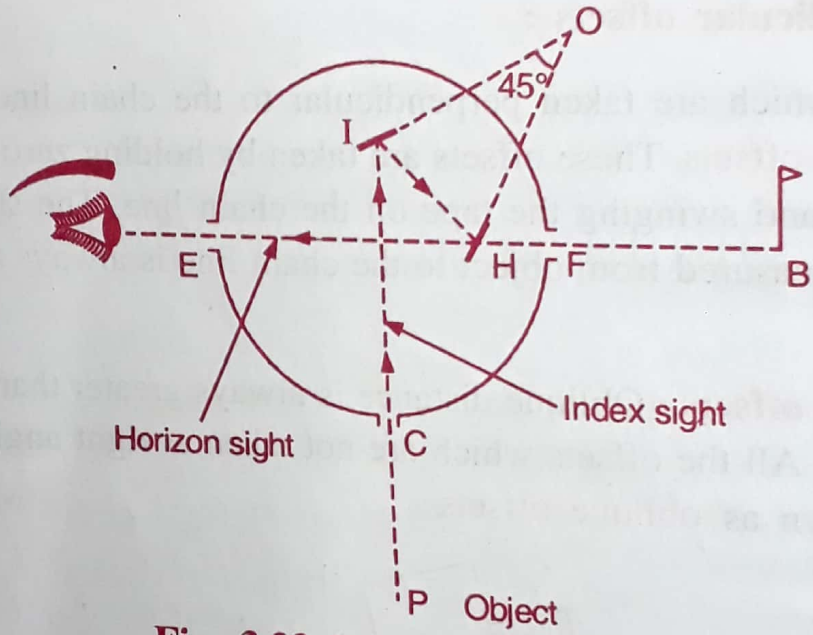


Fig. 3.23 Round optical square

Construction and Working of Optical Square :

The optical square consists of a circular box 50 mm in diameter and 1 mm in depth. The box has three slits at E, F and C. In line with the openi at E and F, a glass H silvered at top and plain at bottom, is fixed. It fac towards E. Opposite of opening C, a silver painted glass I called index gl is fixed so that the inclined edge of glass I and inclined face of glass makes angle of 45° (Fig. 3.23). When opening C face towards object offset, the image will strike to the index glass I and reflected to horiz glass (H). From this horizon glass H, the image received from glass I w be reflected and received by a surveyor holding the instrument and looki through opening E.

Setting up the perpendicular by optical square :

(1) The observer should stand on the chain line and approximately at position where the perpendicular is to be set up.

(2) The optical square is held by the arm at the eye level. The ranging rod at the forward section B is observed through the unsilvered portion on the lower part of the horizon glass.

(3) Then the observer looks trough the upper silvered portion of the horizon glass to see the image of the object P.

(4) Suppose the observer finds that the ranging rod B and the image of object P do not concide, then he should move forward or backward along the chain line until the ranging rod B and the image of P exactly concide Fig. 3.23(a) and 3.23(b).

(a) (b)

Fig. 3.23 (a) and (b)

(5) At this position the observer marks a point on the ground to locate the foot of the offset for the given object. Measure length and chainage of offset.

(2) Indian optical square :

It is a brass wedge shaped hollow box of about 5 cm sides and about 3 cm deep with a handle about 8 cm long fixed underneath.

m_1 and m_2 are two mirrors fixed to the inclined sides of the box at an angle of 45°; ab and cd are two rectangular openings above mirrors. PQRS is the open face which is to be turned towards the object to which the offset is to be taken.

Principle of working and method is same as optical square.

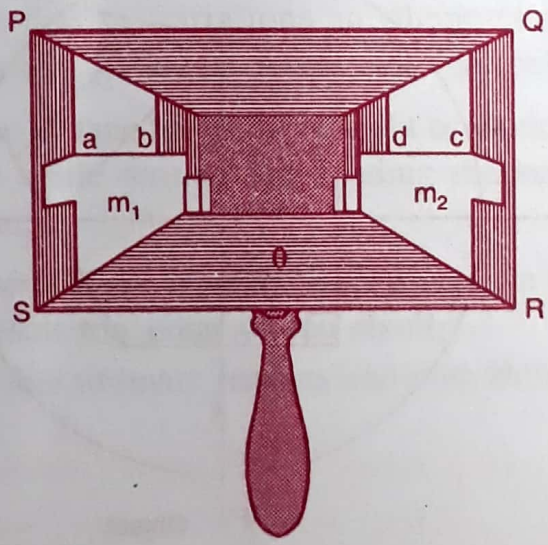


Fig. 3.24 Indian optical square

(3) Open Cross Staff : (GTU June 2009, September 2009)

This instrument is the simplest form among all and consists of four meta arms with vertical slits for sighting through at right angles to each othe as shown in the Fig. 3.25.

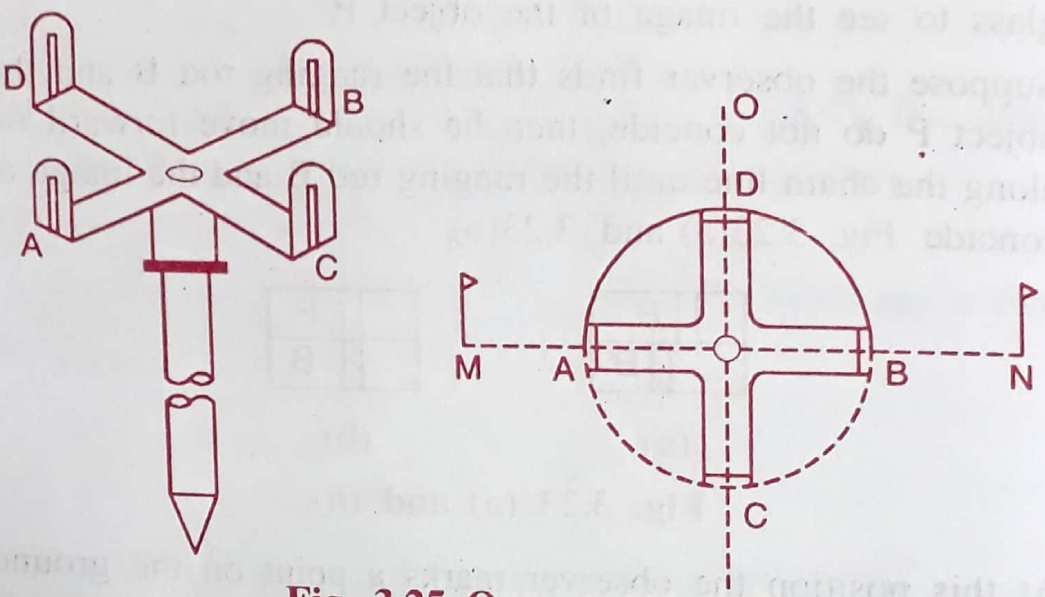


Fig. 3.25 Open cross staff

Two persons are required for this instrument. One pair of vertical slit is t bisect ranging rod at the end of the given chain line by standing on the chai line and other pair of vertical slit is required to be in line with a ranging ro object for perpendicular offset. If this happens, the point on the chain lin the base of the perpendicular offset from object to chain line. The vertica point is marked on the chain line to measure perpendicular offset and chainage To set out angles of either 45° or 90°, French cross staff is used.

(4) Prism Square :

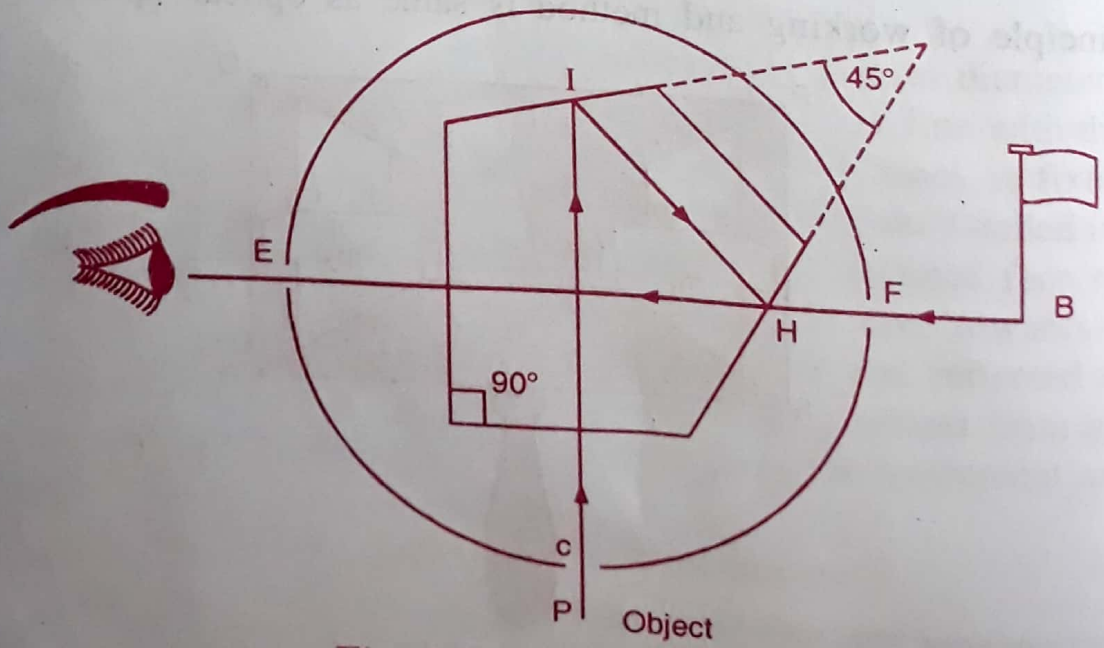
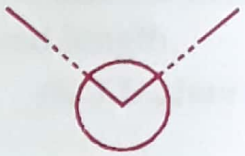
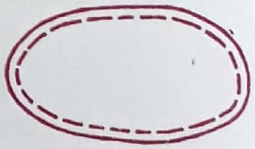
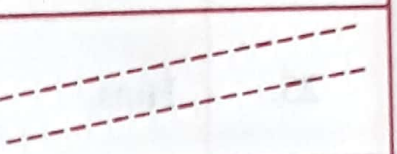
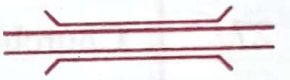
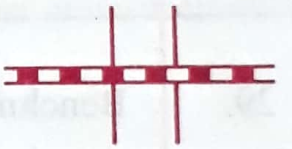
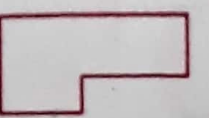


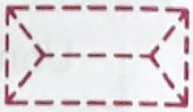
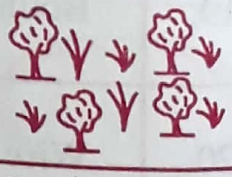
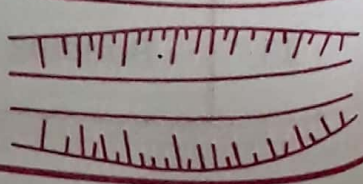
Fig. 3.26 Prism square

3.9 CONVENTIONAL SYMBOLS :

In a map the objects are shown by symbols and not by names. So the surveyor should know the following standard conventional symbols for some common objects.

Sr. No.	Object	Symbol
1.	North line	
2.	Main stations or triangulation stations	
3.	Traverse stations or substations	
4.	Chain line	
5.	River	
6.	Canal	
7.	Lake or pond	
8.	Open well	
9.	Tube well	
10.	Footpath	

Sr. No.	Object	Symbol
11.	Metalled road	
12.	Unmetalled road	
13.	Railway line (single)	
14.	Railway line (double) **(GTU, April 2010)**	
15.	Road bridge or culvert **(GTU, April 2010, June 2012)**	
16.	Railway brdige or culvert	
17.	Road & Rail level crossing	
18.	Wall with gate	
19.	Boundary line	
20.	Wire fencing	
21.	Pipe fencing	
22.	Wooden fencing	
23.	Building (pukka)	

Sr. No.	Object	Symbol
24.	Building (katcha)	
25.	Huts	
26.	Temple	
27.	Church	
28.	Mosque	
29.	Benchmark	
30.	Tree	
31.	Jungle	
32.	Cultivated land	
33.	Embankment	
34.	Cutting	

Sr. No.	Object	Symbol
35.	(a) Telegraph line	
	(b) Telegraph post	
36.	(a) Electric line	
	(b) Electric post	
37.	Burial ground or cemetery	

✶ REMEMBER KEY POINTS ✶

1. In surveying the distance between two points means a horizontal distance.
2. Measurement of horizontal distances or measuring linear measurements is required in chain surveying.
3. **Methods of measuring linear measurements.**
   - (i) Direct methods
   - (ii) Optical method
   - (iii) E.D.M. methods
4. **Approximate methods :** Pacing, passometer, pedometer, odometer, speedometer, measuring wheel etc.
5. **Instruments used in chaining are :**
   (1) Chains, (2) Tapes, (3) Arrows,
   (4) Ranging rods and offset rods,
   (5) Pegs, (6) Plumb bob etc.
6. **Various types of chains used in surveying are :**
   (1) Metric chain
   (2) Gunter's chain or surveyor's chain
   (3) Engineer's chain
   (4) Revenue chain
   (5) Steel band or band chain

7. Various types of tapes used in surveying are :

(1) Cloth or linen tape (2) Fibre tape
(3) Metallic tape (4) Steel tape
(5) Invar tape

8. Chain surveying : Chain surveying is the type of surveying in which only linear measurements are taken in the field.

9. Principle of chain surveying is to divide the area into a number of triangles of suitable sides. A network of triangles (triangulation) is preferred to in chain surveying.

10. Terms related with chain surveying :

(1) Survey stations :

(a) Main stations, (b) Subsidiary stations and (c) Tie stations

(a) Main stations : Stations taken along the boundary of an area as controlling points are known as 'main stations'.

(b) Subsidiary stations : Stations which are on the main survey lines or any other survey lines are known as 'subsidiary stations'.

(c) Tie-stations : These are also subsidiary stations taken on the main survey lines.

(2) Main survey lines : The lines joining the main stations are called 'main survey lines'.

(3) Base line : The line on which the framework of the survey is built is known as the base line.

(4) Check line : The line joining the apex point of a triangle to some fixed points on its base is known as the check line.

(5) Tie line : A line joining tie stations is termed as tie line.

11. Selection of survey stations :

(1) The stations should be intervisible.
(2) Survey stations/lines should be minimum.
(3) Stations should form well conditioned triangles.
(4) Survey stations should be so located that tie lines, check lines, base line etc. can be formed.
(5) Station points should be selected within the boundary of the area.
(6) The survey lines should be taken through fairly level ground.

12. Operations in chain surveying :

(1) Chaining (2) Ranging and (3) Offsetting

13. **Chaining :** The method of taking measurements with the help of a chain or a tape is termed as chaining.

Chaining involves following operations :

(1) Fixing the stations

(2) Unfolding the chain

(3) Ranging

(4) Measuring the distance (survey lines)

14. **Chaining on sloping ground :** (i) Direct method (ii) Indirect method

15. **Hypotenusal allowance** 'a' $= l\ (\sec\theta - 1)$

where l = length of chain in m.

16. **Ranging :** The process of establishing intermediate points on a straight line between two end points is known as ranging.

Methods of ranging :

(1) Direct ranging – By naked eye

– By line ranger

(2) Indirect ranging or Reciprocal raning

17. **Offsetting :** The method of taking perpendicular distances from the chain line to the objects which are to be plotted is known as offsetting.

18. **Offset :** The distance measured from object to chain line is termed as an offset.

Types of offsets :

(a) Perpendicular offsets : The offsets which are taken perpendicular to the chain line are termed as perpendicular offsets.

(b) Oblique offsets : The offsets which are not taken at right angle to chain line are known as oblique offsets.

19. **Instruments for laying offsets :**

(1) Optical square

(2) Indian optical square

(3) Open cross staff

(4) Prism square

20. **Errors in chaining :**

(1) Cumulative errors : The errors, which occur in the same direction and tend to accumulate are called cumulative errors.

(2) Compensating errors : The errors, which occur in either direction and tend to compensate (balance) are called compensating errors.

21. **Sources of errors in chaining are :**

(1) Instrumental errors (2) Natural errors (3) Personal errors

✶ EXERCISE ✶

1. What are different methods of making linear measurements ? Describe briefly them.
2. Discuss various approximate methods of linear measurements. What is their importance ?
3. What are the various instruments used in chaining ? Describe briefly.
4. Define the following terms :
   (i) Main station (ii) Subsidiary station (iii) Tie station
   (iv) Base line (v) Checkline (v) Tie-line
5. Describe how you will measure the distance between two stations on fairly level ground.
6. Explain different methods of chaining on a sloping ground. Discuss the advantages and disadvantages of each method.
7. What is ranging ? Explain direct ranging with a neat sketch.
8. What do you understand by indirect ranging ? Describe it in detail with neat sketch.
9. What are different errors in chaining ? Discuss sources of errors in chainng.
10. Differentiate between :
    (i) Gunter's chain and Engineer's chain
    (ii) Metalic tape and steel tape
    (iii) Ranging rod and offset rod
    (iv) Oblique offset and prependicular offset.

✶ OBJECTIVE TYPE QUESTIONS ✶

1. In chain surveying field work is limited to
   (a) linear measurements only
   (b) angular measurements only
   (c) both linear and angular measurements
   (d) none of the above
2. Chain survey is recommended when the area is
   (a) crowded (b) undulating
   (c) simple and fairly level
3. Ranging is defined as
   (a) measuring the distance from starting point
   (b) measuring the distance from end point
   (c) establishing intermediate points on a chain line
   (d) to take an offset from a chain line

4. Chainage in chain survey means
   (a) The distance between end stations
   (b) The perpendicular distance of the object from the chain line
   (c) Any distance measured by chain in field
   (d) The distance of the object along the chain-line from the zero end of the chain

5. In chain survey the area is divided into
   (a) Rectangles (b) Triangles
   (c) Squares (d) Circles

6. A triangle is said to be well-conditioned when its angles should lie between
   (a) 30° and 120° (b) 30° and 150°
   (c) 30° and 180° (d) 15° and 115°

7. Cross-staff is used for
   (a) setting out right angles (b) measuring horizontal angles
   (c) both (a) and (b) (d) none of above

8. The chain man who drags the chain is called the
   (a) Captain (b) Leader
   (c) Follower (d) Labour

9. The maximum tolerances in a 20 m and 30 m chain are.
   (a) ± 2 mm ± 8 mm (b) ± 3 mm ± 5 mm
   (c) ± 5 mm ± 8 mm (d) ± 5 mm ± 10 mm

10. The angle of intersection of the two plain mirrors of the optical square is
    (a) 30° (b) 45°
    (c) 60° (d) 90°

11. The field records of the chain survey is entered in
    (a) Exercise book (b) Field book
    (c) Level book (d) Account book

12. A tie line is run
    (a) to check the accuracy of field work
    (b) to locate details which are away from the chain line
    (c) parallel to the survey line
    (d) between main survey lines

13. The correction for sag is

(a) always additive (b) always substructive

(c) always zero (d) none of above

14. Correction for slope is given by

(a) $\frac{h^2}{2L}$ (b) $\frac{h}{L}$ (c) $\frac{h}{2L}$ (d) $\frac{2h^2}{L}$

15. Which of the following instrument can be used for setting out 45° on chain line? **[G.T.U., Winter 2013]**

(a) Cross-staff (b) French cross-staff

(c) Prism square (d) Optical square

16. Invar tape is made of an alloy of **[G.T.U., Winter 2013]**

(a) copper and steel (b) brass and nickel

(c) brass and steel (d) steel and nickel

17. In metric chain, number of links per meter can be **[G.T.U.,Winter 2013]**

(a) 2 (b) 5 (c) 4 (d)

18. Total station take measurements of **[G.T.U.,Summer 2014]**

(a) Length (b) Angle

(c) coordinates (d) All of the above

19. Offset are set by instrument **[G.T.U.,Summer 2014]**

(a) Cross staff (b) Prism square

(c) Optical square (d) All of the above

20. Principle of chain surveying is

(a) Triangulation (b) Traversing (c) Parallelism (d) Orientation

21. If q be the angle of slope and L be the slopping distance, slope correction is given by **[G.T.U., Winter 2014]**

(a) L(1-sinq) (b) L(1-cosq) (c) L(1-secq)

Objective Answers

1. (a)	**2. (c)**	**3. (c)**	**4. (d)**	**5. (b)**	**6. (a)**	**7. (a)**
8. (b)	**9. (c)**	**10. (b)**	**11. (b)**	**12. (b)**	**13. (b)**	**14. (a)**
15. (b)	**16. (d)**	**17. (b)**	**18. (d)**	**19. (d)**	**20. (a)**	**21. (b)**